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Muscle contraction exercise for low back pain

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Background: Low-back pain (LBP) continues to be one of the main problems for which sufferers seek treatment in primary care. It can be treated with different physiotherapy mechanisms.
Objective: The purpose of the study is to compare the effect of isotonic and isometric exercise on the reported pain of patients with low back pain.
Methods: Thirty participants, 16 males and 14 females aged between 22 and 50 years suffering from nonspecific low back pain were included. The sample was divided randomly into two groups, group A isometric exercises and group B isotonic exercises, both groups received conservative therapy of TENS and infrared (IR) therapy. The following outcome measures were used: Visual analogue scale, modified Oswestry disability index (MODI) and Endurance Test Measurement were administered pre-treatment and at the end of four weeks of treatment.
Results: Both groups were comparable in terms of demographic data, except for weight. Inter group analysis was done using the Mann–Whitney test. When comparing pre- and post-treatments using VAS scores, there were no significant differences between group A and group B (pre-test: $P = 0.285$; Post-test: $P = 0.838$). Mann–Whitney test was used to calculate the P-value test between pre-treatment and post- treatment for MODI and there was no significant difference between group A and group B, where the pre-test P-value was 0.061, and post-treatment was 0.077. Comparing between groups, pre- and post-abdominal endurance scores were done using the Mann–Whitney test. The pre-treatment scores revealed P value of 0.345, and the post-treatment scores revealed P value of 0.305. Therefore, there is no statistically significant difference between group A and group B in endurance scores.
Conclusion: There was no difference between the use isotonic and isometric exercises on LBP patients.

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Keywords: Isometric exercises; isotonic exercises; core muscle; low-back pain.

Introduction

Low-back pain (LBP) continues to be one of the main problems for which sufferers seek treatment in primary care,[1] and presents a large challenge to the healthcare system despite improving scientific technology, medical insight, and suggested management strategies.[2] Therefore, according to the Palestinian Ministry of Health, the prevalence of LBP in the Palestinian persons reached to 59.4%.

Non-specific LBP is defined as LBP not attributable or recognizable, known specific pathology (e.g., infection, tumour, osteoporosis, lumbar spine fracture, structural deformity, inflammatory disorder, radicular syndrome, or cauda equine syndrome). Non-specific low back is often associated with a history of lifting or twisting while holding heavy object, operating a machine that vibrates, prolonged sitting, fall, coughing, sneezing, and straining.[3,4] Non-specific LBP develops into chronic low back pain (CLBP), which is defined as mild to severe pain in the lower back that has lasted for more than three months, morning stiffness, sleep interruptions due to pain tiredness and/or irritability, depression, and inability to sit or stand for long periods of time.[1,5]

In the treatment of CLBP, the focus has been on analgesia and limited activity. However, this approach is not ideal and can lead to harmful effects.[6] Currently, clinical recommendations are focused on the use of a biopsychosocial framework to guide the treatment of patients. This method supports the use of education and daily activities, but it does not recommend routine use of complementary tests.[7,8]

Majiwala B and his colleagues reported the effect of isometric and isotonic exercise training on core muscle in patients with non-specific LBP. As a result, both isometric and isotonic exercises are equally effective in reducing pain, increase endurance, and improve functional disability in patients with non-specific LBP.[9]

Van Tulder *et al.* reported that exercise for the treatment of LBP was effective in accelerating improvements in daily life activities and return to work.[10] In a meta-analysis, the patients with LBP treated with exercise therapy showed a significant improvement in terms of pain and functional status, compared to the patients who received no treatment or other conservative treatments.[11]

Therefore, the purpose of this study is to compare the effect between the isometric and isotonic exercises on pain, functional disability, and endurance on students and employees of PAU in Bethlehem, suffering with LBP.

Methods

It was a comparative study conducted in the physiotherapy department of Allied Medical Science Faculty. Ethical permission was obtained from the Faculty Ethical Committee, Allied Medical Science Faculty, Palestine Ahliya University, Palestine. The sample study was calculated by the following equation: $n = (Z_{\alpha/2} + Z_{\beta})^2 * 2 * \sigma^2/d^2$, where $Z_{\alpha/2}$ is the critical value of the normal distribution at $\alpha/2$, Z_{β} is the critical value of the normal distribution at β, σ^2 is the population variance, and d is the difference you would like to detect.

A total of 36 patients (18 males and 18 female) were selected in orthopaedic clinic according to inclusion and exclusion criteria. To address the issue of LBP, a special announcement was made by the Palestine University's physical therapy department. It invited patients to visit, its specialist for a free examination. Written informed consent was obtained and the study procedures were explained. A detailed musculoskeletal evaluation was done to screen the patients. Participants were equally divided into two groups, enrolled in the study and randomly assigned to one of the two groups. Baseline treatment was given to both the groups which consisted of transcutaneous electrical nerve stimulation (TENS) and IR. Group A was given isometric exercise ($N = 18$, $M = 9$, $F = 9$) and group B was given isotonic exercise ($N = 18$, $M = 9$, $F = 9$). All patients were divided randomly. Three patients in group A and three patients in group B dropped out for personal reasons. Sessions were performed for 1 h, three times weekly, for four weeks.

Inclusion criteria were as follows: (1) Both male and female, (2) Age group 22–50 years, (3) Patients willing to participate in exercise program, and (4) History of LBP for three months.

Exclusion criteria were as follows: (1) Any back injury or pathology within the previous six months, (2) History of back surgery, (3) Rheumatologic disorder, and (4) Spine infection.

Isometric exercises

Curl up: Supine lying, one leg straight, the other leg flexed at 90°, support lower back with hands, elbow on the floor, keep torso and neck in line, engage core in raising head, and shoulders slightly off the ground. Three repetitions, hold 10 s and rest 10 s.

Side bridge: Side lying, lie on side with knees bent and prop upper body up on elbow, raise hips off the floor, and three repetitions, hold 10 s and rest 10 s.

Bird dog: Quadruped position, both hands are under the shoulders and knees are under the hips, opposing arms and legs raised off the floor separately. Three repetitions, hold 10 s and rest 10 s.

Isotonic exercises

Bent knee sit-up: Supine lying, hands by side, knee flexed 60°, heels flat on floor, head and upper back raise. Three repetitions, hold 10 s and rest 10 s.

Cross curl up: Supine lying, bent knee about 60°, feet flat on the floor, hands placed behind neck, one leg across the other, the participant raised their contralateral elbow to the opposite knee. Three repetitions, hold 10 s and rest 10 s.

Prone back extension: Prone lying, bodies cantilevered over the end, lowered their upper body at 90° of table after feet were secured with a strap and return to starting position. Three repetitions, hold 10 s and rest 10 s.

Post-intervention scoring was recorded on the last day of treatment in the form of pain on visual analogue scale (VAS), functional disability on modified Oswestry disability index (MODI), and strength on endurance test. The partial curl-up has been recommended as a better test of abdominal muscular endurance. The curl-up with knees flexed and feet unanchored has been selected because individually these elements have been shown to (a) decrease movement of the fifth lumbar vertebra over the sacral vertebrae, (b) minimize the activation of the hip flexors, (c) increase the activation of the external and internal oblique's and transverse abdominals, and (d) maximize abdominal muscle activation of the lower and upper rectus abdominals relative to disc compression (load) when compared with a variety of sit-ups. Equipment's and Facilities: Mat, timer and a measuring strip are needed. The strip wide should be 12 cm < 45 years and 8 cm > 45 years for measuring distance. We used a timer of 40 s. Patient lies in a supine position on the mat, knees bent at an angle of approximately 140°, feet flat on the floor, legs slightly apart, arms straight and parallel to the trunk with palms of hands resting on the mat. The fingers are stretched out and the head is in contact with the mat. Make sure patient has extended his feet as far as possible from the buttocks while still allowing feet to remain flat on floor and when test is started, Therapist counts curl-ups during 40 s and determine percentiles according to age group and gender for partial curl-up.

"Percentiles by Age Group and Gender for Partial Curl-Up"

	Age									
	(20–29)		(30–39)		(40–49)		(50–59)		(60–69)	
PERCENTILES	M	F	M	F	M	F	M	F	M	F
90	75	70	75	55	75	50	74	48	53	50
80	56	45	69	43	75	42	60	30	33	30
70	41	37	46	34	67	33	45	23	26	24
60	31	32	36	28	51	28	35	16	19	19
50	27	27	31	21	39	25	27	9	16	13
40	24	21	26	15	31	20	23	2	9	9
30	20	17	19	12	26	14	19	0	6	3
20	13	12	13	0	21	5	13	0	0	0
10	4	5	0	0	13	0	0	0	0	0

Notes: *This table is from the NSCA's Essentials of Personal Training, p. 257

Data analysis

Statistical analysis of the data was made with 95% confidence in the SPSS 15.0 for Windows package program. Categorical variables were shown as "n" and "%", and continuous variables as "Mean ± standard deviation". Independent sample's *t*-test was used to study the similarity of demographic data between groups. Wilcoxon Signed Ranks Test was used to study the change between pre- and post-treatment. Mann–Whitney Test was used to study the comparison between both groups.

Results

For this study, 30 ($n = 30$) subjects, 53% of the participants were males and 47% were females, they were selected to compare the effectiveness of

Table 1. Comparisons of demographic data between groups.

Variables	Group A Mean (SD)	Group B Mean (SD)	t-value	p-value
Age	30.13 (12.84)	30.47 (8.69)	−0.083	0.934
Weight (Kg)	76.33 (17.75)	71.87 (11.67)	−16.36	0.000
Height (Cm)	169.5 (8.08)	167.3 (12.15)	0.583	0.564
BMI	26.7 (6.38)	25.8 (4.16)	0.460	0.649

Note: BMI: Body Mass Index; W: Weight; H: Height; SD: standard deviation.

isometric and isotonic exercises for training core muscles in decreasing pain intensity, improving functional disability and abdominal endurance test for low-back pain patients. These subjects were then randomly divided into two groups, group A ($n = 15$) and group B ($n = 15$).

The demographic data is shown in Table 1. In both groups, there were no significant differences in terms of age, height, and BMI; but there were significant differences in weight.

Within groups, analysis of VAS score was done using Wilcoxon Signed Ranks Test. The result of the test in group A shows that the P value is (0.001) which is less than $P = 0.05$. The results revealed that the average on pain pre-treatment was (6.67), while post-treatment decreased to (3). Thus, we infer that isometric treatment reduces lower back pain significantly. In group B, the results revealed that P is equal to 0.019. Moreover, the result showed that the average pain pre-isotonic treatment was 5.9, whereas the average pain post-treatment reduced to 4.6. Table 2 presents these findings.

Between groups, analysis of VAS score was done using Mann–Whitney Test for the pre- and post-results of the both groups. In the pre-values, the results of the test disclosed that the P value before the two approaches was 0.285. Thus, we conclude that there was no statistically significant difference between the pain in group A and group B before the treatment. This means that the two groups are considerably identical.

Table 2. Comparison between pre- and post-VAS score within groups.

Group	Pre-treatment Mean (SD)	Post-treatment Mean (SD)	p-value
A (ISOMETRIC)	6.67 (1.71)	3.0 (1.69)	0.001
B (ISOTONIC)	5.9 (1.3)	4.6 (5.8)	0.019

Note: VAS: Visual analogue scale, SD: Standard deviation.

Table 3. Comparison of pre- and post-MODI score within groups.

Group	Pre-treatment Mean (SD)	Post-treatment Mean (SD)	p-value
A (ISOMETRIC)	23.5 (14.8)	9.5 (9.48)	0.001
B (ISOTONIC)	34.4 (16.4)	14.0 (8.02)	0.001

Note: MODI: Modified Oswestry Disability Index and SD: Standard deviation.

In the results from the two approaches, the P value in post-tests was equal to 0.838, which is greater than 0.05. Therefore, we conclude that there is no statistically significant difference between the two approaches. This also means that they have the same effect and reduce the pain. Table 3 and Fig. 1 illustrate these findings.

Within the groups, MODI scores were done using Wilcoxon Signed Ranks Test. When comparing the pre- and post-MODI scores in group A (isometric treatment), the results showed that the P value is equal 0.001, this means that there is statistically significant difference between pre- and post-MODI scores. In group A, the average MODI score pre-isometric treatment was 23.5%. While post-treatment decreased to 9.5%. Consequently, we can conclude that isometric treatment can improve MODI scores significantly.

Similarly, the P value in group B (isotonic treatment) was 0.001, which is less than 0.05. Hence, we conclude that there is statically significant difference between pre- and post-MODI scores. Examining the average score of MODI before and after the isotonic treatment revealed that the average MODI score in group B before the treatment was 34.4%. In the post-measures, the average decreased to 14.0%. This also means that isotonic treatment can improve MODI scores significantly. Table 4 depicts these results.

To compare pre- and post-MODI scores in between groups, we used Mann–Whitney Test. The test on the pre-treatment scores revealed P value of 0.061, which is greater than 0.05.

Thus, we conclude that there is no statically significant difference between the two groups in MODI scores before the treatment. Moreover, this means that the two groups are indistinguishable. In the same way, the test on the post-treatment scores revealed P value of 0.077. Again, this value is

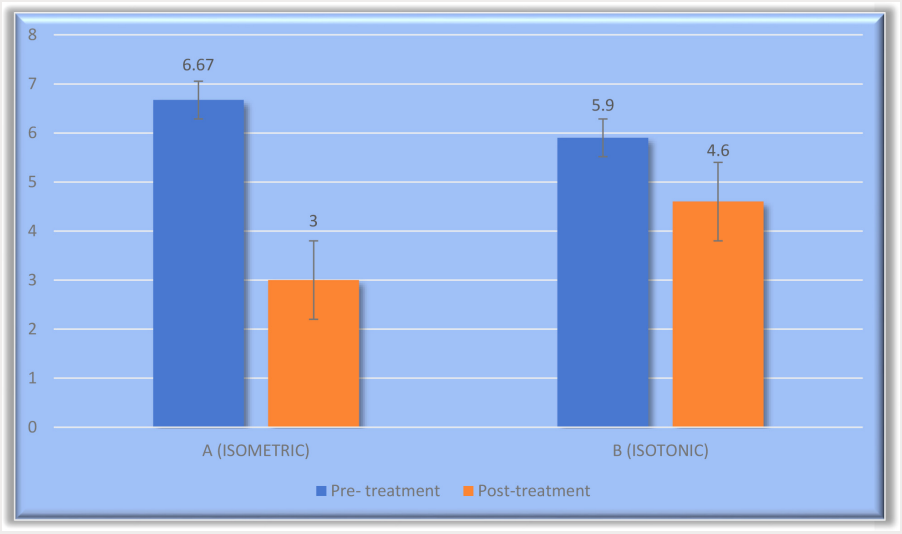

Fig. 1. Comparison of pre- and post-VAS score in between groups.

Table 4. Comparison of pre- and post-abdominal endurance test within groups.

Group	Pre-treatment Mean (SD)	Post-treatment Mean (SD)	*p*-value
A (ISOMETRIC)	35.9 (10.61)	47.5 (11.39)	0.001
B (ISOTONIC)	35.3 (18.46)	52.7 (17.09)	0.001

Note: SD: Standard deviation.

greater than 0.05, and thus we infer that there is no statistically significant difference between group A and group B in MODI scores after the treatment. This also means that the two approaches improve patients MODI scores equally. Table 5 and Fig. 2 illustrate these findings.

Comparing between groups, pre- and post-abdominal endurance scores were done using the Mann–Whitney Test. The test on the pre-treatment scores revealed P value of 0.345, which is greater than 0.05. Thus, we conclude that there is no statistical significant difference between the two groups in abdominal endurance scores before the treatment. Moreover, this means that the two groups are indistinguishable. In the same way, the test on the post-treatment scores revealed P value of 0.305. Again, this value is greater than 0.05, and thus we infer that there is no statistically significant difference between group A and group B in abdominal endurance scores after the treatment. Tables 5 and 6 and Fig. 3 show these results.

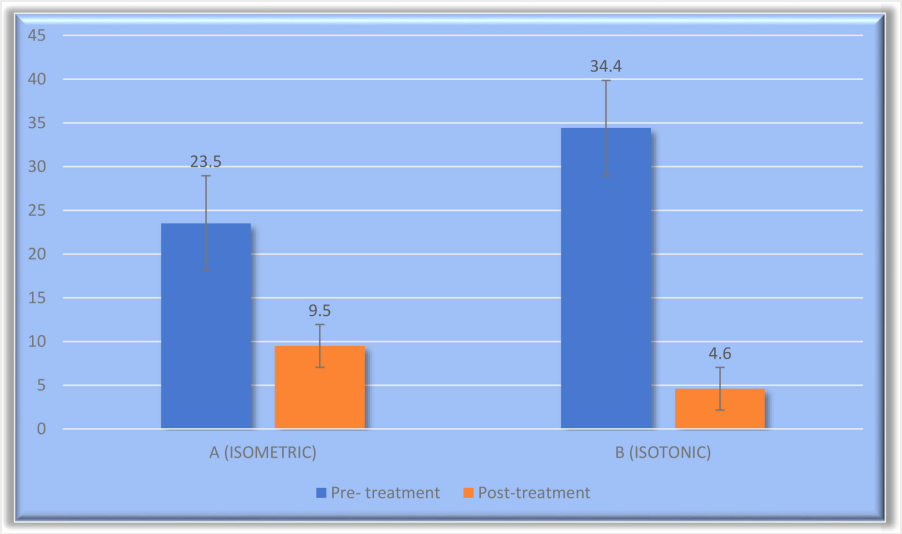

Fig. 2. Comparison of pre- and post-MODI score between groups.

Table 5. Comparison of pre- and post- MODI score between groups.

	Pre-treatment	Post-treatment
Group	Mean ± (SD)	Mean ± (SD)
A (ISOMETRIC)	23.5 ± 14.8	9.5 ± 9.48
B (ISOTONIC)	34.4 ± 16.4	14.0 ± 8.02
P value	0.061	0.077

Note: Modified Oswestry Disability Index, SD: Standard deviation.

Table 6. Comparison of pre- and post- abdominal endurance test between groups.

	Pre-treatment	Post-treatment
Group	Mean ± (SD)	Mean ± (SD)
A (ISOMETRIC)	35.9 ± 10.61	47.5 ± 11.39
B (ISOTONIC)	35.3 ± 18.46	52.7 ± 17.09
P value	0.345	0.305

Note: Standard deviation.

Discussion

The purpose of this study is to compare the effect of isometric and isotonic exercises training in patients with non-specific LBP. The results showed that both isometric and isotonic exercises significantly reduce pain, and improve function and abdominal muscle endurance in patients with LBP. Intergroup analyses were done using Mann–Whitney Test and the results of the study confirm the hypothesis that there was no a significant difference between the two groups.

Hye Jin Moon *et al.* reported the effect of lumbar stabilization and dynamic lumbar strengthening exercises in patients with CLBP. As a result, both lumbar stabilization and dynamic strengthening exercise (isometric strength) strengthened the lumbar extensors and reduced LBP. However, the lumbar stabilization exercise was more effective in lumbar extensor strengthening and functional improvement in patients with nonspecific chronic LBP.[12] In our study, results revealed that isometric and isotonic approaches have a positive value for functional improvement in patients with nonspecific LBP.

In isotonic exercises, when a body segment moves through its available range, the tension that the muscle is capable of generating shortens or lengthens which is due to the changing length, tension relationship of the muscle, and the changing load. Hence, the isotonic exercise helps in relieving pain and improving strength by both of these mechanisms.

Jill and colleagues reported that Exercise Therapy for Nonspecific Low Back Pain, exercise therapy seems to be slightly effective at decreasing pain and improving function in adults with CLBP, particularly in health care populations. In subacute low-back pain populations, some evidence suggests that a graded activity program improves

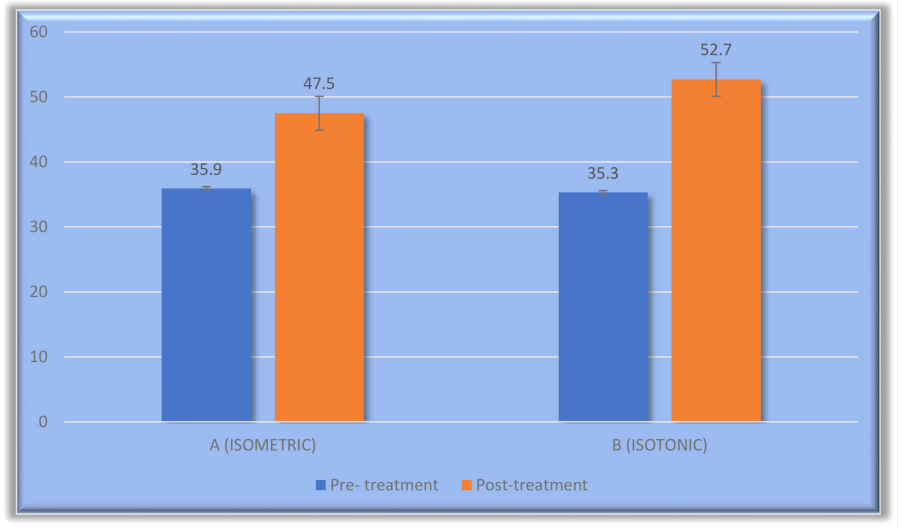

Fig. 3. Comparison of pre- and post-abdominal endurance test between groups.

absenteeism outcomes, although evidence for other types of exercise is unclear. In LBP populations, exercise therapy is as effective as either no treatment or other conservative treatments.[13]

Leemans and his colleagues reported TENS and heat to reduce pain in a chronic LBP population, the study results indicated that the combination of heat and TENS does not reduce pain scores in patients with CLBP. Pressure pain threshold values significantly improved, showing beneficial effects of the experimental treatment.[14] Our study results indicated that the isotonic and isometric exercises with TENS and IR decrease the pain.

Park *et al.* indicated that an exercise program that simultaneously strengthens the deep abdominal muscles and muscles of trunk is an ideal method for maintaining spinal stability physical balance.[15] In our study between groups, pre- and post-abdominal endurance scores were done using the Mann–Whitney test. We conclude that there is no statistically significant difference between group A and group B in abdominal endurance scores after the treatment. It means that both isometric and isotonic exercises increase the abdominal endurance.

The result from the statistical analysis of this study supported null hypothesis which stated that there will be no significant difference in isometric and isotonic exercise training in core muscle in patient with non-specific LBP for all other outcome measures. Thus, it can be stated from the study that isometric and isotonic exercises along with infrared and TENS are effective in treating patients with LBP.

Conclusion

From the finding of this study, we can conclude that both isometric and isotonic exercises are effective when treating low-back pain. There was no difference between the effects of isometric and isotonic exercises to decrease pain intensity, improvement in disability, and abdominal muscles endurance.

Conflict of Interest

The author has no conflict of interest.

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Author contributions

The authors confirm contribution to the paper as follows: study conception and design: Azzam Alarab,; data collection: Azzam Alarab and Ratib Abu Shameh; analysis and interpretation of results: Azzam Alarab and Muntaser S. Ahmed; draft manuscript preparation: Azzam Alarab. All authors reviewed the results and approved the final version of the manuscript.

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